國立中央大學 105 學年度碩士班考試入學試題

所別： 通訊工程學系碩士班 不分組(一般生)　　　　共2頁　第1頁

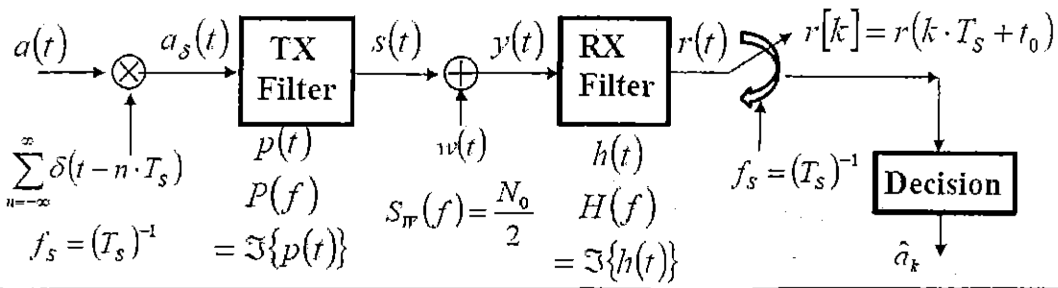
科目： 通訊系統

本科考試禁用計算器　　　　*請在答案卷(卡)內作答

1. For a baseband communication system as shown below, where $w(t)$ is the additive white Gaussian noise with a power spectral density $N_0/2$ and $p(t)/h(t)$ denote the impulse responses of TX/RX filters, (a) find the values of A_0 and f_0 in $s(t)=A_0\cdot\cos(2\pi\cdot f_0\cdot t)$ when $a(t)=\cos(2\pi\cdot 0.8\cdot f_S\cdot t)$ and $P(f)=\begin{cases}1, & |f|\le 0.5f_S\\ 0, & otherwise\end{cases}$ (6%); (b) plot the Fourier spectrum $A_\delta(f)=\Im\{a_\delta(t)\}$ in the range $|f|\le 2f_S$ when $A(f)=\Im\{a(t)\}=\begin{cases}1, & |f|\le 0.25f_S\\ 0, & otherwise\end{cases}$ (5%); (c) plot the waveform $s(t)$ in the range $0\le t\le 5\cdot T_S$ when $p(t)=\begin{cases}1, & 0\le t\le 0.5T_S\\ 0, & otherwise\end{cases}$ and $\{a(n\cdot T_S)\,|\,n=0\sim 4\}=\{1,-1,1,1,-1\}$ (5%); (d) find the received signal (noise) power $\left(E\{r^2(t)\}\right)$ when $H(f)=\begin{cases}2, & |f|\le 0.5f_S\\ 0, & otherwise\end{cases}$ and $s(t)=0$ (5%); (e) find the values A_0 and $E\{n_k^2\}$ in $r[k]=A_0\cdot a(k\cdot T_S)+n_k$ when $t_0=0.5\cdot T_S$ and $h(t)=p(t)=\begin{cases}1, & 0\le t\le 0.5T_S\\ 0, & otherwise\end{cases}$ (6%); (f) repeat (e) except that $h(t)=p(t)=\begin{cases}1, & 0\le t\le 0.75T_S\\ 0, & otherwise\end{cases}$ (6%); (g) find the optimal decision rule and decision error probability (i.e. $\hat{a}_k\ne a(k\cdot T_S)$) in terms of $Q(\bullet)$ for the received sampled signal given in (e) when $a(k\cdot T_S)\in\{-A,3A\}$ (digital binary communications) (12%); (h) express the decision error probability in a form of $Q\left(\sqrt{?\frac{E_b}{N_0}}\right)$ (5%) .

$\left(\text{Hint}: Q(x)=\frac{1}{\sqrt{2\pi}}\int_x^\infty \exp\left(\frac{-y^2}{2}\right)dy\right)$

$\left(\text{Hint}: s(t)=a_\delta(t)*p(t)=\sum_n a(n\cdot T_S)\cdot p(t-n\cdot T_S),\quad \Im\{\ \}:\text{Fourier Transform}\right)$



注意：背面有試題

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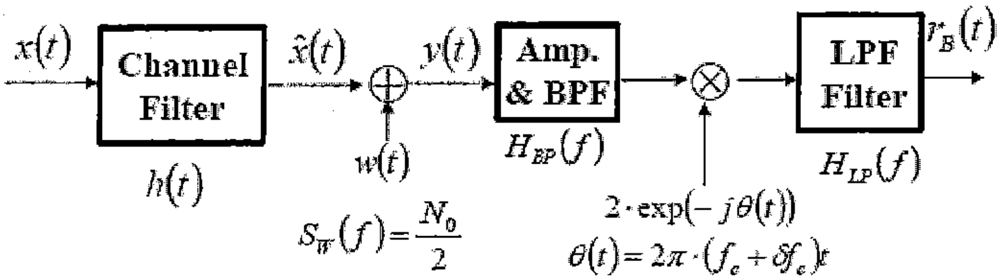
2. For a bandpass communication system as shown below with the TX bandpass signal given by $x(t)=\mathrm{Re}\{s_B(t)\cdot\exp(j2\pi\cdot f_c t)\}$, $s_B(t)$ being the baseband signal,

$$H_{BP}(f)=\begin{cases}G_A,\ f_c-0.5B\le|f|\le f_c+0.5B\\ 0,\quad \text{otherwise}\end{cases}\qquad \text{and}\qquad H_{LP}(f)=\begin{cases}1,|f|\le 0.5B\\ 0,\text{otherwise}\end{cases}$$

$(B:\text{bandwidth of } x(t))$, (a) find the formula of $s_B(t)$ and the bandwidth B when $x(t)$ is an FM signal with $m(t)$ and $f_d\ (Hz/V)$ denoting the message signal and the frequency deviation constant (5%); (b) find the formula of $\hat{s}_B(t)$ in terms of $s_B(t)$ when $\hat{x}(t)=\mathrm{Re}\{\hat{s}_B(t)\cdot\exp(j2\pi\cdot f_c t)\}$ and $h(t)=\alpha_0\cdot\delta(t-\tau_0)+\alpha_1\cdot\delta(t-\tau_1)$ (5%); (c) find the formula of $r_B(t)$ in terms of $\hat{s}_B(t)$ when $w(t)=0$ (5%); (d) find $E\{|r_B(t)|^2\}$ when $\hat{x}(t)=0$ (5%); (e) find $E\{|\hat{x}(t)|^2\}$ in terms of $E\{|r_B(t)|^2\}$ when $\delta f_c=0$ and $w(t)=0$ (5%). $\left(\text{Hint}: e^{j\cdot x}=\cos(x)+j\cdot\sin(x),\quad \mathrm{Re}\{e^{j\cdot x}\}=\cos(x)\right)$



3. For a random system given by $Z_1=\alpha_1\cdot A+N_1$ and $Z_2=\alpha_2\cdot A+N_2$, where N_1 and N_2 are the independent zero-mean Gaussian random variables with $\mathrm{var}\{N_1\}=\mathrm{var}\{N_2\}=\sigma_n^2$, (a) find the optimal value of β_1 in terms of α_1 and σ_n^2 such that $E\{|\beta_1\cdot Z_1-A|^2\}$ is minimized (5%); (b) find the optimal values of β_1 and β_2 in terms of α_1, α_2 and σ_n^2 such that $E\{|\beta_1\cdot Z_1+\beta_2\cdot Z_2-A|^2\}$ is minimized . (5%)

4. Explain the following terms: (15%)
   (a) Entropy of a discrete random variable;
   (b) Hamming distance between two binary code words;
   (c) 16-QAM;
   (d) Raised-Cosine Spectra;
   (e) Auto-correlation of a wide-sense stationary random process.

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